PART III

ALTERNATIVES TO THE PROPOSED ACTION

PART III

ALTERNATIVES TO THE PROPOSED ACTION

A. Introduction

The proposed action is approval of the New Hampshire Coastal Program as an amendment to the existing New Hampshire Coastal Program Ocean and Harbor Segment. All federal alternatives to the proposed action involve a decision to delay or deny approval. To delay or deny approval could be based on failure of the New Hampshire Coastal Program to meet any one of the requirements of the Federal Coastal Zone Management Act (CZMA). In approving this amendment, affirmative findings must be made by the Director of the Office of Ocean and Coastal Resource Management (OCRM) on over twenty requirements.

A unique situation exists regarding the delay or denial of approval of the New Hampshire Coastal Program. Section 306(h) of the CZMA allows for a coastal program to be developed and adopted in segments so that immediate attention may be devoted to those areas of the coastal zone which most urgently need management programs. The Ocean and Harbor Segment was approved in June 1982. The CZMA is very specific regarding the need for ultimate coordination of the entire state coastal program. Section 306(h) states that segmented approval is conditioned with the provision "that the State adequately provides for the ultimate coordination of the various segments of the management program into a single, unified program and that the unified program will be completed as soon as reasonably practicable." This amendment combines the Ocean and Harbor Segment with the remaining Great Bay area into a single unified coastal program: the New Hampshire Coastal Program. Should the Director of the Office of Ocean and Coastal Resource Management delay or deny approval based on failure of the unified program to meet any one of the requirements of the CZMA, Section 306(h) does not allow the previously approved segment of the coast to remain approvable.

New Hampshire's response to the need for a unified coastal program has been to combine nine core regulatory programs and 16 policies into a comprehensive program to manage coastal resources. The program is carried out by a network of state agencies coordinated by the Office of State Planning. Conflict resolution for the networked state agencies is provided by the Council on Resource and Development.

Development of the New Hampshire Coastal Program has taken several years. Alternative approaches, including different forms of legislation and different coastal boundaries, have been introduced. Of particular concern throughout program development was the comprehensiveness of the program to achieve the goals and objectives of the CZMA. This issue is addressed in Alternative 4.

During development of the New Hampshire Coastal Program areas of potential deficiencies were identified. Following revisions to the New Hampshire Coastal Program, the Director of the Office of Ocean and Coastal Resource Management has made a preliminary determination that any such deficiencies have been addressed and that New Hampshire has met the requirements for

program approval under Section 306 of the CZMA.

In an effort to elicit public and agency comment and assure that the Director's determination is correct, this section provides for the alternative to delay or deny approval based upon any deficiencies identified through the public review process. Before examining the alternatives, the following section identifies the generalized impacts that would result from delay or denial on any basis.

1. Loss of Federal Funds to Administer the Program - Under Section 306, New Hampshire would receive approximately $500,000 in FY 1987 to administer its coastal management program. The loss of Federal Section 306 funds would result in the inability of the State to continue to provide adequate staffing and administrative support to coordinate and evaluate coastal actions, implement state coastal programs, address priority issues, and assure that government agencies coordinate and operate consistently with coastal policies. State technical assistance to local governments, essential for the development of a more effective coastal management program, would also be curtailed due to limited funds. Local governments would also be without the pass-through funds necessary to address local coastal resource issues. To deny approval of this amendment would also make it difficult for the State to coordinate and expedited resolution of inter-agency conflicts and establish unified state policies for state investments and actions in the coast.

2. Loss of consistency of federal actions with the program -- Approval of the amendment would mean federal actions in or affecting the coastal area would have to be consistent with the New Hampshire Coastal Program under section 307(c) of the CZMA. Loss of Federal consistency with the State's coastal program would have significant and adverse effects on the resources of the state's coastal area.

FEDERAL ALTERNATIVES

Alternative 1: The Director could approve the New Hampshire Coastal Program.

The Director's preferred alternative is to approve the New Hampshire Coastal Program. Program approval would have an overall positive impact on the environment. Program approval would mean that New Hampshire would continue to receive funds under Section 306 to administer their program; if such funds are made available pursuant to Congressional appropriations. These funds would positively impact the States ability to enhance their current management efforts. Program approval would also mean that Federal actions would be subject to the consistency provisions of Section 307 (c) and (d) to determine their consistency with the New Hampshire Coastal Program.

Alternative 2: The Director could delay or deny approval if the policies of the program are not specific enough to meet the requirements of the Federal Coastal Zone Management Act.

Coastal Zone Management Act (CZMA) regulations 923.11(b)(2) and 923.(b)(4) require that coastal policies must provide a clear sense of direction and predictability for decision makers who must take actions pursuant to or consistent with the management program. Specificity is particularly important when such policies will be administered by a variety of state agencies. It is also important to assure that State administered policies are not subject to an excessively broad range of interpretations.

The Director has made a preliminary decision that the policies contained in the New Hampshire Coastal Program provide sufficient specificity for approval. This decision is based on the fact that the policies are derived from existing state laws and regulations.

Alternative 3: The Director could delay or deny approval if the boundary is not adequate to meet the requirements of Section 304(1) - definition of the coastal zone and 923.31(a) of the CZMA regulations - inland boundaries.

Section 304(1) of the CZMA states that the coastal zone shall extend inland from the shoreland only to the extent necessary to control shoreland uses which have a direct and significant impact on coastal waters. The State has established a two-tiered inland boundary.

The first tier occurs along the Atlantic Ocean, along the Piscataqua River to a location on Dover Point opposite the outlet of Stacey Creek on the Maine Shore, and in most areas of the Great and Little Bay. This first tier is 1,000 feet inland from mean high water or to the limit of the Wetlands Board's jurisdiction which extends 3 1/2 feet above mean high tide, whichever is further inland. The boundary around Great and Little Bay extends inland to identifiable features, roads or railroad tracks which are in most cases more than 1,000 feet inland and which effectively separate the shoreland from inland areas.

The second tier includes the following tidal rivers: the Piscataqua (from Dover Point), the Bellamy, Oyster, Lamprey, Squamscott and Winnicutt, to the limit of tidal action and adjacent areas inland to the Wetlands Board jurisdiction. Maps which show the coastal boundaries in greater detail are on file at the Office of State Planning.

The issue can be raised that the second tier boundary is not adequate to control shoreline uses which have a direct and significant impact on coastal waters. The Director has made a preliminary decision that the area within which the state will be regulating activities is adequate to control uses which have a direct and significant impact on coastal waters. A detailed discussion justifying the boundary can be found in Chapter 2, Part II.

Alternative 4: The Director could delay or deny approval if the program is not adequately comprehensive to achieve the goals and objectives of the Coastal Zone Management Act as expressed by Congress in Section 302 and 303 of the Act.

The Director has made an initial determination that the New Hampshire Coastal Program is adequately comprehensive in scope.

In 1972 in creating the CZMA, Congress found "in light of competing demand . . . present State and local institutional arrangement for planning and regulating land and water uses in such areas are inadequate." (CZMA Section 302(h)).

The initial determination of approvability was reached on the basis of the strong laws already in place in New Hampshire that met many of the concerns Congress expressed in 1972 about institutional arrangements in all States.

One could question if New Hampshire has adequately addressed the Congressional finding (CZMA Section 203(g)) that aesthetic values are being destroyed by ill-planned development. The preliminary approval was based on draft regulations which amend Chapter 600 of the State Wetlands Board Regulations. The draft regulations, contained in Appendix B of the DEIS, will be promulgated pursuant to RSA 483-A before the New Hampshire Coastal Program receives final federal approval. Under these regulations all projects requiring a Wetlands Board permit are reviewed for their impacts on the aesthetic character of the surrounding land. The criterium is in addition to the procedures and criteria otherwise applicable under RSA 483-A. The State Wetlands Act is fully discussed in Chapter 3 and 5 of Part II.

One could also question if New Hampshire is addressing the "increasing and completing demands upon the lands and waters of the coastal zone . . . " (CZMA 302(c)).

The preliminary determination of approvability was reached on the basis that the State manage competing land uses through direct public ownership and controlling public investment in infrastructure. Approximately 78% of the Atlantic shoreline is publicly owned. Furthermore, over 60% of the land within 1,000 feet of the Atlantic shoreline is public or managed by the State. In the Great Bay area Memoranda of Agreements will be used to limit public investment in sewer facilities, water supply systems and roads. A Memorandum of Agreement will be signed with the State Water Supply and Pollution Control Commission limiting publicly funded waste water treatment facilities and extensions to solving specific pollution abatement problems or to serve existing development in an area and limiting State funding of water supply systems. The Memorandum will be in effect before the Coastal Program receives final federal approval. A similar Memorandum of Agreement has been signed with the State Department of Transportation. The agreement limits public investment in coastal highway projects to maintenance of existing coastal routes, bridge replacement projects, the planned upgrading/replacement of Route 4 and improved public access to coastal waters. Control of public infrastructure is addressed in detail in Section II, Policy 8 of Chapter 3.

Alternative 5: No Action.

Taking no action would have the same impact as delaying or denying approval.

PART IV:

AFFECTED ENVIRONMENT

PART IV

DESCRIPTION OF THE AFFECTED ENVIRONMENT

The environment to be affected by the New Hampshire Coastal Program consists of both natural and man-made components. The Ocean and Harbor and Great Bay areas are discussed separately.

A) OCEAN AND HARBOR AREAS

Natural Environment

The New Hampshire seacoast is a part of the arcadian biogeographic region. It is influenced by two river basins, which drain into the Atlantic Ocean. The Atlantic shoreline is composed of beaches behind which are formed embayments with well-developed tidal mud flats and marsh systems. The shoreline is interspersed with rocky outcrops of primarily unconsolidated glacial material which provide the sand and silt material for nourishment of the beach areas.

The coastal waters of New Hampshire are influenced both by tidal flow and by the presence of the Gulf of Maine. Net circulation flow is to the south during most of the year with some variability due to storms and other irregular phenomenon. Water salinity is stable except near the rivers where there is a significant inflow of fresh water. Water temperatures vary from 36 F in the winter to 66 F in summer. Air temperatures vary between an average of 33 F in January and an average of 69 F in July.

The land area covered by the Ocean and Harbor section of the coastal program includes almost 12,000 acres. The area extends inland 1000 feet or to the limits of the Wetlands Board jurisdiction. A significant portion of this land area, roughly 65%, consists of natural resource areas. The dominant natural areas are predominantly undeveloped and either publicly owned or managed through the Wetlands Board.

Tidal wetlands cover approximately 6,600 acres or half of the entire coastal impact area. The marsh system consists of perennial grass of the Spartina genus. They are found in low energy environments which drain slowly as a result of tidal influence. The Hampton-Seabrook marsh system is the largest pristine marsh area within the coastal segment. It contains clam beds and provides significant nutrients to the coastal ecosystem. Tidal wetlands establish the inland boundary for coastal development along the state's highly developed barrier islands. Prior to the 1960's, tidal wetlands were unprotected and subject to development. The state now recognizes the value of tidal wetlands as natural habitats for fish and wildlife and protects such areas for spawning, habitats, and nutrient sources.

Of New Hampshire's 18 mile Atlantic coastline, 57% is beachfront. Virtually all of this beachfront is accessible for public recreation and enjoyment. Less than 1/10 mile is privately owned. Many of the larger

beaches, particularly those with nearby parking and other facilities are heavily used. Smaller beaches are less widely used due to limited available parking. Chronic beach erosion occurs in only one place, the northern end of Hampton Beach. This is periodically alleviated with sand from the maintenance dredging operations in the Hampton Harbor channel. The beaches provide significant recreational opportunity to residents and non-residents alike, and are a major summer tourist attraction which bolsters the seacoast economy.

Undeveloped sand dunes are found only in the southern portion of the seacoast where three discrete areas remain in the towns of Seabrook and Hampton: the Hampton Beach State Park foredunes which are owned and managed by the state; the foredunes along Seabrook beach which are owned by the town and regulated by the Wetlands Board; and the Seabrook back dunes, a large undeveloped complex adjacent to the marsh, which is also ownedby the town and subject to state and local regulations. The remaining foredunes provide protection from wave damage from coastal storm flooding. The back dunes also absorb coastal waters during periods of flooding. The entire remaining dune system is important as a habitat for many species of wildlife, in particular small migratory land birds. The dune system is also home to several rare and endangered plant species, including: Ammophila breviligulata, Arenaria peploides var. Robusta, Aristida tuberculosa, Artemisia caudata, Cenchrus iongispinus, Cyperus grayii, and Hudsonia tomentosa var. Tomentosa. Since most of the sand dune areas along New Hampshire's coast have been destroyed through development, the retention of these few remaining natural dune areas are of particular importance.

New Hampshire has 8200 acres of coastal flood hazard areas. A significant portion of these flood hazard areas are coterminous with tidal wetland areas, where floodwaters are absorbed and slowly released with minimal damage to surrounding areas. Generally, coastal towns can withstand periodic flooding of storms with minimal damage. Larger, more infrequent storms, like the 1978 blizzard, can cause more widespread damage. This type of winter storm, a "northeaster" is more likely to occur here than is a hurricane. High winds and storm surge are associated with these winter storms. Five of the seven coastal towns in the segment have coastal high hazard areas, making them vulnerable to more damage from high velocity waters and storm surge. Fortunately, much of the land along the immediate shoreline is publicly owned and used for recreation, thus minimizing property loss. A system of seawalls provides protection to other sections of the coast and, often, buildings are located landward of the coastal road, away from the water. Although by its nature, New Hampshire's coast is not highly vulnerable to storm damage, the coastal and flood insurance programs seek to minimize the loss of life and property. Several sections of rocky shore outcropping, roughly 32 acres, occur along New Hampshire's Atlantic coast. They are largely in the intertidal area or rise quite steeply to meet the coastal road. In the intertidal and subtidal zones, rocky shores provide a habitat for shellfish and plant life and protect upland areas from damage and erosion by reflecting the impact of waves. At points where the shore meets the coastal road, spectacular scenic vistas are provided.

The estuarine and close inshore waters along the New Hampshire coastline are of vital importance to fisheries and wildlife. The marshes and mud flats of Seabrook and Hampton provide ideal habitats for many species of migratory waterfowl with black ducks and mallards, the most important species, present almost year-round. The area also provides a resting place for congregations of ducks and geese migrating north in the spring and south in the fall. This area is a critical habitat for many species of migratory shore birds, large and small and for herons and egrets. Many mammals also inhabit the marsh, including raccoons, mink, otter, muskrats and deer. The greatest importance of the saltmarsh is to the production of fisheries by supplying needed nutrients. Soft-shell clams and blue mussels live in the intertidal zone and many species of young fin-fish owe their continued existence to the richness of the estuaries and saltmarsh creeks. Lobsters, crabs and other crustaceans also depend upon these shallow, protected areas for their start in life.

The near-shore coastal waters are also very important to fisheries and wildlife in the state. Diving ducks, such as buffleheads, scaup and goldeneyes are found here, as are the so-called "coots", scoters, eiders, old squaws, and red-breasted mergansers. Migratory and wintering loons and grebes, migratory terns, and year round gulls, cormorants (two species), and other sea birds depend on this area for their existence. Seals and occasional porpoises are mammals inhabiting this area. State or federally listed endangered or threatened species include the following species which are found in the coastal area: bald eagles, peregrines, the common loon, marsh hawks, ospreys, arctic and roseate terns, purple martin, piping plover, common tern, least tern, and short-nose sturgeon.

The near shore area - with depths of 100 feet or less - supports most of New Hampshire's lobster fishery. A large majority of lobster traps are set on or near the hard bottom within five miles of shore. Some lobstering by draggers and deep sea pots occurs in offshore areas.

Commercial fishing, with certain limitations, is carried out for flounders, cod and other groundfish, herring, smelt, menhaden and mackerel. It is safe to say that within our limited state jurisdiction every bit of inshore water is of vital importance to fisheries interests.

The offshore coastal waters are important to New Hampshire fisheries even though many of these areas are presently outside the legal jurisdiction of the state. Shrimp, groundfish, mackerel and herring support important commercial fisheries. Giant bluefin tuna are the quarry of both recreational and commercial fishermen.

The party boats, which in late years have depended primarily on mackerel fishing to attract customers, find inshore waters more profitable. Recently the explosion of the bluefish population along New Hampshire's coast has provided an additional species for fishing. The party boat industry is an important factor in the use of certain marine fin-fish. Annual catches on these boats probably exceed several million pounds of mackerel, cod, pollack, haddock, cusk, and other groundfish. The sport fishery occurs in inshore waters as well as in the estuary and parent streams. Recreational fishing for smelt, flounders, cod, haddock and

other ground fish, striped bass and bluefish occurs. Other species harvested, in addition to the above commercial and recreational catches, include: softshell clam, clamworm, green crab, cancer crab, northern shrimp, smelt, hake, pollock, sand eels, cusk and halibut.

New Hampshire's coastal waters are generally of the highest quality - Class A. They can be utilized for swimming purposes and the taking of clams and shellfish for human consumption. Clam flats in the Hampton-Seabrook estuary are closed only during periods of red tide or to maintain adequate population levels to protect against the over- exploitation of the limited resource. Major point sources of pollution discharge into coastal waters have been corrected through public sewerage treatment facilities. The State now regulates subsurface disposal and sewage disposal to protect and maintain surface and groundwater quality in the coast.

In Portsmouth Harbor, the high quality of water is maintained partly as a result of the intense flushing action of the Piscataqua River. A high percentage of the cargo passing through the port is petroleum-related. Although much of it is bound for facilities further upriver in Newington, care must be taken for the difficult navigation through the channel. The majority of petroleum activities are offloading operations which do not require ballasting discharges into the harbor waters. Oil spills have occurred in the river in the past. Due to the tidal action, most spills have been carried inland, into Great bay and Little Bay. To date, no oil spills have occurred which have affected New Hampshire's beaches. Future oil spills may impact the beaches due to the continuing role of Portsmouth Harbor as a major oil port.

Man-Made Environment

The Ocean and Harbor area of the New Hampshire coastal program is found in Rockingham County. The area is within the borders of seven municipalities: Seabrook, Hampton Falls, Hampton, North Hampton, Rye, New Castle and Portsmouth. These seven municipalities have a combined estimated 1985 population of 58,630 which represents a 21% increase from the 1970 population of 46,352. The factors supporting population growth during this period include the proximity of the seacoast to the Boston, Massachusetts metropolitan area and the attractiveness of southern New Hampshire as an area of commercial and industrial expansion. In addition, seasonal population within the seacoast is very high, with population tripling during peak summer days, due to the fact that the seacoast is a major tourist destination.

Recreation and tourism is centered on the Atlantic shoreline with Hampton Beach a focus of commercial activity and a heavy influx of seasonal residents. Along the Atlantic, 78% of the shoreline is publicly owned and managed for recreational use. Public access to the water is excellent for swimming, boating, fishing, clamming and sightseeing. Over ten miles of public beaches line the coast.

Boat moorings are available in the harbor areas and are regulated by the Port Authority. Existing spaces at moorings and slips number 1,200 and increased demand is forecasted. Trailered boats can be launched at a

number of public launch sites (see Figures 3-1 and 3-2). Large party fishing boats leave daily from each harbor for recreational fishing and fisherman often utilize the bridges over the many tidal rivers and creeks. The taking of soft-shell clams is strictly recreational. Licenses are issued only to state residents and a limit is set for daily harvest per person. Approximately 18,000 licenses are issued annually. Sightseeing excursions to the Isles of Shoals, seven miles offshore, are operated by a private company in Portsmouth Harbor. Whalewatching tours to Jeffrey's Ledge, 50 miles offshore, are popular and run during the spring and fall whale migration periods.

Commercial fishing is a small but significant portion of the seacoast economy. It is supported by three commercial fish piers owned and operated by the state, located in the three harbors. Prior to the establishment of these piers, local fisherman landed their catch in neighboring states. The three piers receive heavy use and Portsmouth, with ice and berthing facilities, has reached capacity. Lobstering and ground-fishing are the major activities and the product is sold either locally or through the Portsmouth or Newburyport (Massachusetts) Fishing Cooperative.

The Port of Portsmouth is the only deep draft channel in New Hampshire which accommodates oceanborne commerce. Water dependent industrial activities are limited to Portsmouth Harbor and the Piscataqua River. Along the river in Portsmouth are two bulk cargo docks, a petroleum distribution facility, two electrical generating stations, a tugboat operation, the state fish pier and the New Hampshire State Port Authority cargo terminal. Other petroleum terminals and a liquified petroleum gas facility are located further up the river in Newington. Most of the cargo passing through the port of Portsmouth is petroleum- related products. The State Port Authority promotes commercial and industrial uses of the harbor and regulates navigation and moorings. Periodic dredging of the harbor and river channel is conducted. Waterfront land in this area is entirely developed, 80% for water dependent uses, both commercial and industrial.

Concentrated along Portsmouth's urbanized harbor waterfront is the historic district which includes sections of the central business district. Historic warehouses and residences are now commercial shops and tourist attractions. Within this district, thirty-one buildings and areas have been placed on the National Register of Historic Places. The revival of this area was the impetus behind the revitalization of the entire city into a very attractive place to live and visit. Portsmouth has the only locally established historic district within the Ocean and Harbor area.

Elsewhere on the coast, six other sites have been included on the National Register: in New Castle, Fort Constitution is a Revolutionary War fort maintained by the state parks system; and in Rye, two residential homesteads and the Isles of Shoals are listed on the Register. The Isles of Shoals is a cluster of rocky islands seven miles offshore with an historic hotel and other buildings. Sightseeing and nature groups visit daily in the summer. The state, through the state park system, maintains

several historic sites and properties along the coast. Also included are the Reuben Lamprey Homestead in Hampton, and the Unitarian Church in Hampton Falls.

B) GREAT BAY AREAS

Natural Environment

The Great Bay area is a classic example of an estuarine system and represents one of the finest remaining relatively unspoiled estuarine systems on the Atlantic coast. The entire system extends from Portsmouth Harbor, up the Piscataqua River to the junction with Little Bay, into Little and Great Bays, and up the tributary rivers.

Seven major rivers flow into the estuary basin including the Salmon Falls and Cocheco Rivers which converge to form the upper Piscataqua River, and the Bellamy, Oyster, Lamprey, Squamscott (Exeter) and Winnicut. The rivers and the embayment drain an area of 930 square miles, two thirds of which is located in New Hampshire. Estuarine (tide) waters cover a geographic area of 11,000 acres (17 square miles); shoreline length is about 100 miles.

Great Bay, beginning at Adams Point, is a large tidal flat, a wide shallow bay (8.85 feet average) being cut through by a network of channels. Much of this shallow area is exposed as mudflats during low tide. A small channel from the Winnicut and large ones from the Squamscott and Lamprey Rivers join in the center of the bay to form a main channel which connects to Little Bay at Adams Point.

North of Adams Point, Little Bay proper extends to Dover Point and can be viewed in two sections. The portion of Little Bay which extends from Dover Point to Fox Point has several distinguishing features, including Broad Cove, Goat Island, Fox Point (a promontory which extends into the Bay) and Cedar Point. Little Bay turns sharply at Fox Point and extends two miles to Adams Point via a broad channel with one obstruction -- Seal Rock, a reef which cuts from Sasafrass Island to mid-channel. Mud flats band the channel.

At Dover Point, the upper Piscataqua joins Little Bay, an L-shaped body of water with two fresh water tributaries, the Bellamy and Oyster Rivers. All waters entering and leaving the embayment (Great and Little Bays) pass through the constricted channel at Dover Point which is 470 yards wide and which has a maximum depth of 35 feet.

Geology

Events which directly influenced Great Bay took place in the last million years. A southeastward flow of glacial ice scoured the rock surface and then deposited a blanket of glacial till. In the coastal lowlands, which were flooded by the sea, clays and silts accumulated. Withdrawal of the sea left stream, shore and swamp deposits to form.

Extensive sand plains and terraces were formed in the lowland area when the glacial front receded. In the vicinity of Great Bay, a glacial

moraine crosses the basin from northeast to southwest. The rocky outcroppings at Dover Point are of the Eliot formation. Substrate materials present at the Point vary from boulders to cobbles, pebbles, sand and mud. Locations to the northeast and southwest of Dover Point are for the most part composed of mud substrate; occasional rock outcroppings, cobbles, shells, and artificial substrates are also present.

Current flow in the estuary is predominantly tidal and velocities vary considerably throughout the system. In the upper basin, tidal currents are lower. Currents decrease slightly in Little Bay, and then increase sharply in the narrow channel at Dover Point (up to 6 knots), these swift currents equal some of the strongest of the Atlantic coast. These currents, coupled with hard bottom substrate, are important in supporting greater numbers and diversity of marine vegetation.

Water temperature and salinity vary (-2 to 32 degrees Celsius and 1 to 33 ppt respectively) throughout the seasons of the year as climate and hydrological conditions change. Temperature and salinity stratification do occur during fresh water runoff periods, but during the rest of the year strong tidal currents and reduced runoff result in a vertically well-mixed water column throughout the estuary.

There is a wide range of temperatures in Great Bay, both daily and seasonally, due to its shallow depth. Surface water salinity also varies seasonally. Maximum salinity values are evident in the fall when there is the least amount of fresh water input to the estuary and the lowest values occur during the spring thaw. Salinities also tend to be lowest in the upper reaches of the estuary and during ebb tide.

A 1983 study of Great Bay, "Long-Term Environmental Trends in Nutrient and Hydrographic Data from the Great Bay Estuarine System," carried out by a team of researchers at the University of New Hampshire, found the estuarine water quality to be good. The study, using eight-plus years of data on certain physical and chemical parameters, focused on the long-term impact of sewage treatment plants and other sources of nutrients on water quality in the estuary. They also looked for any trends in physical parameters, such as temperature and salinity. The research team found that, "although other estuaries have experienced major eutrophication [an overload of nutrients] problems during the last decade, this has not occurred in the Great Bay Estuary because of rapid assimilation of nutrients within the inflowing tidal rivers, a large ratio of tidal prism to sewage volume, and vigorous tidal mixing. These features have combined to maintain an elevated nutrient carrying capacity within the system." They also found small but significant trends showing an increase in salinity and a decrease in temperature, for which the causes are uncertain.

Vegetation

The Great Bay estuarine system provides a finely varied habitat for many different species of vegetation. These include marine algae, seaweeds, salt grasses, and fresh water marsh grasses. This vegetation is the driving force behind estuarine productivity. The various plants and grasses provide oxygen in the water, act as stabilizers for the estuary

bottom, and provide food and habitat for many different species of fish, shellfish, birds and other wildlife.

Several species of algae are more prevalent than others. The rock weeds Ascopyllum nodosum, Fucus spp., and Chondrus rispus are the dominant intertidal (between high and low tide) algae to inhabit the estuary on hard substrate. Another rockweed, Fucus vesiulosces L. var. sporalis, also dominates the intertidal macroalgae found on rock ledges, boulders, and shingle-like fragments. Chondrus crispus is a member of the red algae, Rhodophycea, and is commonly known as Irish Moss, a major source of carageenan which is used in the production of gelatin. Other species are more rare.

Halophytes (salt tolerant plants) such as marsh grasses and Zostera marina L. (eelgrass), provide detrital inputs, decayed plant material that serves as a food source. Zostera beds located throughout the estuary are also extremely valuable as stabilizers of bottom sediments. As a protection habitat and food supply, eelgrass is important to many invertebrates, fish, and waterfowl.

Saltmarsh plays a very important role in the estuarine system. In addition to the above-mentioned functions of the marsh grasses, the marsh traps nutrients from the water column and converts them into a viable food source, and it serves as a "sponge" to absorb wave and flood energy. Prevalent species found in the marshes include Spartina patens (saltmeadow grass), Spartina alterniflora (smooth cordgrass), and Juncus gerardii (black grass). Spartina pectinata, a freshwater cordgrass, is found in the freshwater marsh that is adjacent to some of the saltmarsh.

Fish and Wildlife

Marine life in Great Bay has a richly varied environment including saltmarshes, mudflats, sandy beaches, and rocky shorelines. The most prevalent habitat in the estuary consists of soft substrata intertidal areas - those areas between high and low tides.

Because of tidal fluctuations, faunal species are alternately exposed to wet and dry conditions as well as changes in temperature and salinity. Representative intertidal species include polychaetes (worms), amphipods (very small crustaceans), and bivalves. These animals are important in transporting sediments and redepositing them as well as being important to the food web complex. Bivalves of significance to man are soft shell clams, razor clams, and blue mussels.

Predominant subtidal (below the tide) fauna in Great Bay include polychaetes, crustacea, and mollusks. Of the three, the crustaceans and mollusks are of recreational and commercial value to people. There is limited dragging for sea scallops in the mouth of Portsmouth Harbor; soft shell clams, mussels and oysters are found in Great Bay and are taken on a limited recreational basis. Major oyster beds are located in Great Bay, and the Oyster, Bellamy, and Piscataqua Rivers. Of the crustaceans, lobsters and rock crabs are harvested commercially. Hermit crabs and star fish have also been found in the estuary.

The estuary serves as an important breeding ground for many species of finfish. A two-year (1980-82), comprehensive inventory of the natural resources of Great Bay*, conducted by the Fish and Game Department, identified 52 different species of finfish - some resident, some anadromous, and some migrant. The most abundant species were Atlantic silversides, rainbow smelt, killifish, river herring, Atlantic tomcod, white perch, and winter and smooth flounder. (Appendix H lists the 52 species). Limited commercial fishing exists for river herring, American eel and rainbow smelt, while important recreational species include striped bass, rainbow smelt, winter flounder, alewives and coho salmon.

This same resource inventory sighted over 90,000 birds representing 71 different species during the two-year period. (Appendix H lists the 71 species). These birds can be generally grouped into four categories; seabirds, waterfowl, wading birds, and terrestrial shorebirds. Of the seabirds, the most common are herring gulls, terns and cormorants. The most common waterfowl are black ducks, Canada geese and greater scaup; the most common wading birds are great blue herons, snowy egrets, green herons and glossy ibises; and the most common terrestrial and shorebirds are the greater and lesser yellowlegs and the least and semipalmated sandpipers. Five endangered or threatened species were sighted during the inventory; the bald eagle, osprey, marsh hawk, common tern and common loon.

The estuary is also home to several mammals. Harbor seals, racoons, white-tail deer, red fox, woodchucks, muskrats, chipmunks, grey squirrels and cottontail rabbits have been sighted in and around the estuary during various studies.

Man-Made Environment

The affected environment of the Great Bay segment varies from the highly industrialized Piscataqua River shoreline to the quite reaches of the tidal rivers and the tidal mud flats of Great Bay. The New Hampshire side of the Piscataqua River is already highly developed and is almost entirely devoted to water dependent and energy related industries. Along this short stretch of shoreline are located two electrical generating stations, a bulk storage area, an ocean wire and cable manufacturing plant, a fish processing facility, a liquid propane gas storage and distribution plant, and four petroleum storage and distribution facilities.

The water-dependent uses of the estuary include commercial and recreational fishing, clamming/oystering, bird hunting and watching, boating, and the transportation and storage of petroleum products in the Piscataqua River. Commercial fishing in the estuary is limited. There is some lobstering at Little Bay only, and there is some taking of rainbow smelt, river herring and American eel on a commercial basis. There is also a commercial aquaculture project (for oysters) off Fox Point in

---

*Great Bay Estuary Monitoring Survey, Volumes I and II, 1980 - 1982, N.H. Department of Fish and Game

Newington. The estuary is very popular for recreational fishing and shellfishing. There are several sportsmen's groups that actively fish the estuary, as well as many individuals - from the area and from out-of-state - who fish and/or harvest the oysters, clams and mussels.

Pease Air Force Base is located on 300 acres of federal land in Newington. The land along the bay is primarily wooded and is managed as a conservation/recreation area. It is one of the few locations where bluffs can be found, as well as several sheltered coves. Both are found infrequently through the estuary. General public access to this area is not permitted.

Although limited public access to the shoreline, particularly in the upper estuary, does restrict hunting somewhat, duck hunting is a significant seasonal activity. The Bay is also a very popular area for birdwatching. Boating in the estuary is mainly in the lower portions - Little Bay, the Piscataqua River and Portsmouth Harbor. While there is some boating in the upper estuary, the extensive mud flats in Great Bay and the shallow channels in the rivers at low tide tend to discourage all but the most experienced boaters. There are two marinas in Little Bay, a very small marina on the Squamscott River, and four public boat launches in the estuary.

Compared to many other estuarine areas around the country, Great Bay is a relatively undeveloped, pristine area. With the exception of the commercial development on Dover Point in the Little Bay area, and pockets of former seasonal homes now being utilized year-round, such as those at Brackett and Weeks Points, the character of the shoreline is predominantly a mixture of large-lot residential property, agricultural land and woodlands. The following table, based on an inventory of shoreline land use around Great and Little Bays, breaks down the land uses into general categories and gives acreage figures and percent of total area for each category.

GREAT BAY ESTUARY - SHORELINE LAND USE

	Area (in acres)	Percent of Total Area
Total Land Area	6004	-
Tidal Wetlands	594	10%
Freshwater Wetlands	690	11%
Public Land (state, town or federal)	1348	22%
Developed Land (includes residential lots of 9 acres or less and residential/commercial areas)	1154	19%
Open Land (includes large-lot residential, agricultural and woodland)	2218	37%

There are three main reasons for the pattern of development around the estuary: local land use controls that place certain restrictions on shoreline development, the ability - and conviction - of many landowners to retain large parcels of land, and the recreational limitations of the upper estuary at low tide (mud flats, narrow channels). The towns, via their land use controls, have said that the shoreline should be used for residential, agricultural and conservation purposes. Many of these parcels, despite subdivision pressure, are still 50-100 acres or more because many of the landowners are deeply committed to preserving their own homestead and the open character of the area. And finally, Great Bay waterfront property has not received the development pressure typical of shorefront property because boating opportunities are limited at low tide and because many people have not wanted to live adjacent to extensive mud flats.

Projections for future use and development of the estuary indicate a moderate rate of growth for the area. From 1970 to 1985 the ten-town region grew from 45,023 to 64,540, an increase of 43 percent during the 15 year period. By the year 2000, an additional 34 percent growth in population is expected, bringing the population to 80,020. As the number of persons per household decreases, structural growth outpaces population growth. A Recreational Boating Needs Assessment carried out for the State in 1981 projected a need for approximately 100 additional moorings in the estuary by 1990.

This growth translates into more construction activity, more housing and more use of the estuary for recreational purposes. While these changes are not necessarily a threat to the health of the estuary, the impact on the system does need to be carefully evaluated.

Over the last several years, the State of New Hampshire has conducted numerous studies and surveys of the coastal environment. For those persons interested in particular aspects of the coast, they may request information from the Office of State Planning, 2 1/2 Beacon Street, Concord, New Hampshire, 03301, telephone (603) 271-2155.

A selected list of information on file at the Office of State Planning is listed on the following pages.